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ABSTRACT

The opportunities that students have to develop scientific literacy are examined in this study of six high school science programs (four were in California and two in Utah). Factors such as the context for science in the school, curriculum opportunities available to students, and the science experiences students have in classes were explored. Findings are reported about: (1) the schools (describing the participating schools' location, enrollment, and programs); (2) course classification (explaining remedial, general, mixed, and college-prep tracking systems); (3) science curriculum structure (analyzing the availability of science course offerings and the policies and practices that control students' entry to courses); (4) entry options (including grade of entry, course levels available, and placement criteria); (5) exercise of opportunities (discussing policies that affect enrollment); and (6) science experience (examining the emphasis teachers place upon aspects of scientific literacy and the use of instructional strategies). Observations revealed that while scientific literacy components were occasionally introduced into instruction, for the most part they did not form an integral part of the curriculum. Teachers gave priority to facts, methods, and attitudes. Implications for teacher training and for the design and implementation of programs are also discussed. (ML)

OPPORTUNITIES FOR SCIENTIFIC LITERACY IN SIX HIGH SCHOOLS

Opportunity Systems in Science and Technology Study Series

Volume II

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INTRODUCTION

Secondary science education has recently received widespread attention in the media and in the government. In the several reports on education appearing in 1983, science and technology have consistently been targeted as areas in need of immediate attention.

Concern about the quality of education Americans receive in the scientific disciplines is not new. The launch of Sputnik in 1957 brought about major curricular reform in precollege and college science. Whereas the emphasis then was on the preparation of professional scientists, today it is for all Americans to become scientifically literate. The National Science Board Commission on Precollege Mathematics, Science, and Technology Education (1983, p. 2) declared that:

> . . .the position of mathematics, science, and technology, historically at the periphery of learning for all but a few American students, must shift to center stage for all.

In this study, we examined the opportunities of students in six high schools to develop scientific literacy. More specifically, we looked at the ways opportunities were provided or denied to college bound and non-college bound students, and the extent to which these students exercised the opportunities available to them.

We began the study with the proposition that whether or not students attain scientific literacy depends on three factors, 1) the context for science in the school, 2) the curriculum opportunities available to students, and 3) the science experiences students have in classes.

The school service context is made up of things such as the size and socioeconomic status of the school and community, the priority given science in the school, counseling, staff, and graduation requirements. Schools in very small or poor communities, where little counseling is available, or where qualified science staff is unavailable, may have difficulty providing opportunities for learning science.

The opportunities available depend mostly upon the course offerings at the school, the options students have for entering the science curriculum, and the sequences they may follow. In some cases, the curriculum may be arranged so that only college bound students have access to science after the first year of study, but in others, there may be carefully articulated science offerings for students of varied interests and abilities.

Students exercise these opportunities through their choice of courses. We can get an indication of the opportunities students have by examining the numbers of students enrolled in various

courses at different points in their high school career. At some schools, for instance, large numbers of students continue to enroll in science courses in their junior and senior years, but in others, most students stop taking science after ninth grade.

Once enrolled in a science class, students' science experiences, including the kind of instruction they get and the emphasis placed upon aspects of scientific literacy, will also have an effect on the degree of <u>scientific literacy</u> students attain.

SCIENTIFIC LITERACY

Despite the attention given to scientific literacy in the last few years, there is still a lack of agreement as to what exactly is meant by the term. It seems to suggest different things to different people, but most do agree, however, that true scientific literacy is made up of capacities in several different areas of learning and experience. Taken together, the various descriptions of scientific literacy can be combined into an operational definition having five components (Figure 1).

Figure 1

The Components of Scientific Literacy

Scientific Literacy includes:

- Knowledge of science facts and concepts
- Understanding of the process of scientific inquiry
- Understanding of the relationship of science, technology, and society
- Knowledge necessary to maintain good health, be a successful consumer, and cope with a technological world (science for personal use)
- Understanding of the reasoning process of science

For this study, we included two additional components: 1) awareness of vocational or educational opportunities for the further pursuit of science, and 2) an informed attitude toward science.

RESULTS

THE SCHOOLS

Four high schools in California and two high schools in Utah were selected for the study. They were chosen to provide differences in location and enrollment, socioeconomic status of parents, science curriculum and school tracking system. Altogether, two urban, three suburban, and one rural school were included. Area populations ranged from under 10,000 to over 600,000, and schools had enrollments that varied from under 500 to nearly 3000. All but one were four-year high schools, housing grades nine through twelve. There were great differences in ethnic representation at the schools. The two schools in Utah were uniformly white, while those in California included a predominantly Hispanic school, a predominantly Asian school, and two schools where one-fifth the students were Black. The minority enrollment at three of the California schools was 45 percent or greater. The number of science courses ranged from six at Suburban High School in California to 13 at Western High in Utah.

COURSE CLASSIFICATION

An essential part of this study is the way in which we have classified courses by level. Initially, we had thought it might be possible to distinguish tracks into which students were placed for most of their high school career. We soon realized, however, that personnel at most of the sites did not think in terms of tracks, except perhaps in reference to college-prep courses. In addition, the explicit policy in the California schools was to deny the existence of tracks. One could not deny, however, that some courses were intended to be more difficult than others, that some were directed at particular populations of students, and that some courses formed a sequence, while others did not.

We, therefore, classified individual courses into four levels: remedial, general, mixed, and college-prep. <u>Remedial</u> courses are those intended for students with perceived deficiencies, usually in reading. When school personnel or documents explictly stated, for example, that a course was for students reading below grade level, that course was classed as remedial. <u>College-prep</u> courses are designed to prepare students to take college-level science or at least to gain them entry to universities. <u>Mixed</u> courses are ones in which students of varying abilities and interests may be enrolled. <u>General</u> courses have, for the most part, a less academic orientation and are intended for students who may have less ability or interest in science.

SCIENCE CURRICULUM STRUCTURE

By science curriculum structure we mean the science course offerings available to students and the policies and practices that control students' entry to one course and movement to another. In a way, the science curriculum structure is the roadmap that describes the sequences of science courses students may pursue.

We found that the course offerings, course sequences, and enrollment control mechanisms to be quite different across the six schools we studied. These variations in the science curriculum structures at the six high schools are represented in Figures 2 to 7. To compare this feature across schools, we have examined (a) the levels offered, (b) the number of courses offered at each level, and (c) whether the courses at a level are part of an articulated sequence.

The number of science courses available for students ranged from 6 to 14. An obvious explanation for these differences might be the size of the school enrollment and teaching staff, and this certainly accounts for the limited offerings at Mountain, where there are less than 500 students and only two science teachers. Western, however, offers 14 courses, more than twice the number at Suburban with only 400 more students and an equal number of teachers.

Each school offered a sequence of from 3 to 7 college-prep courses. However, outside the traditional college-prep core of Biology, Chemistry, and Physics; we found the courses varied widely across schools. Courses like Advanced Biology were offered at Suburban, for example, and Anatomy/Physiology and AP Biology at Kirkland. One aspect of the curriculum is the same at all six schools, however: college-prep courses seem to be part of a sequence, while courses at other levels are fewer in number and not in sequence.

Graduation requirements also differ somewhat across the six schools. Three of the California schools currently require only one year of science for graduation; the other, Kirkland, requires two. In Utah, students need a year of science plus an additional year of either science or mathematics for graduation. Teachers and administrative staff seemed to think, however, that most students opt for math in the second year, rather than science. By 1988, all six schools will require two full years of science for graduation; in California, 1987 graduates will need to meet this requirement.

Policy choices are reflected as well in the number of preparations teachers are responsible for. At Suburban, for example, teachers must prepare an average of 1.7 different courses per day, while at Western the figure is 3.5 periods every two days. However, because of the longer class periods at Western, if calculated in terms of minutes per day, teachers at Western are responsible for 149 minutes per day, while those at Suburban have to prepare for only 85.

Figure 2

Science Course Chain at Suburban High

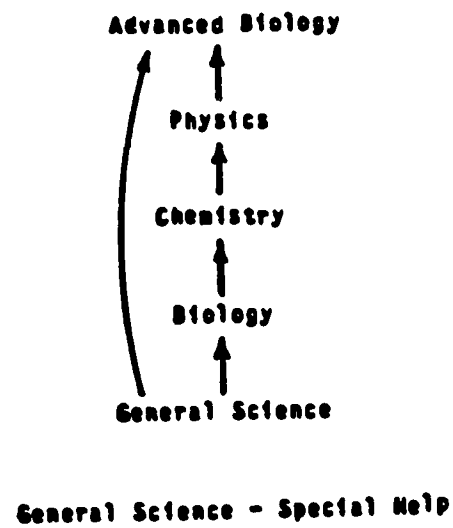


Figure 3

Science Course Chain at Kirkland High

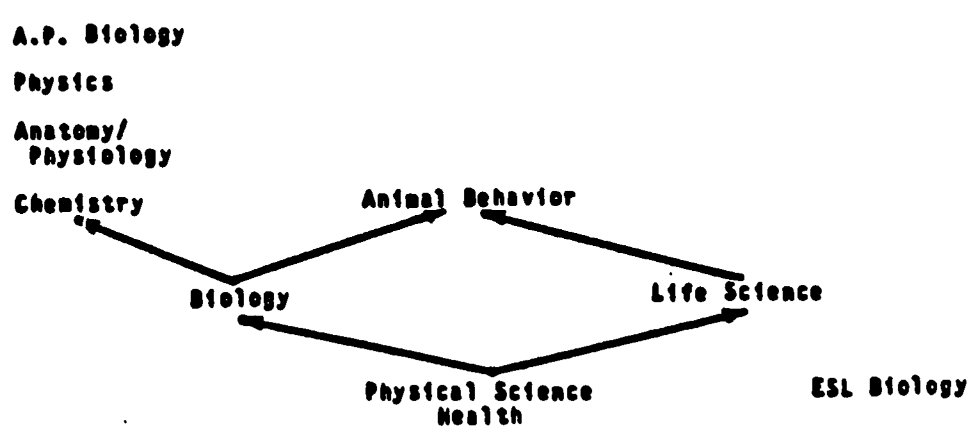


Figure 4

Science Course Chain at Vista High

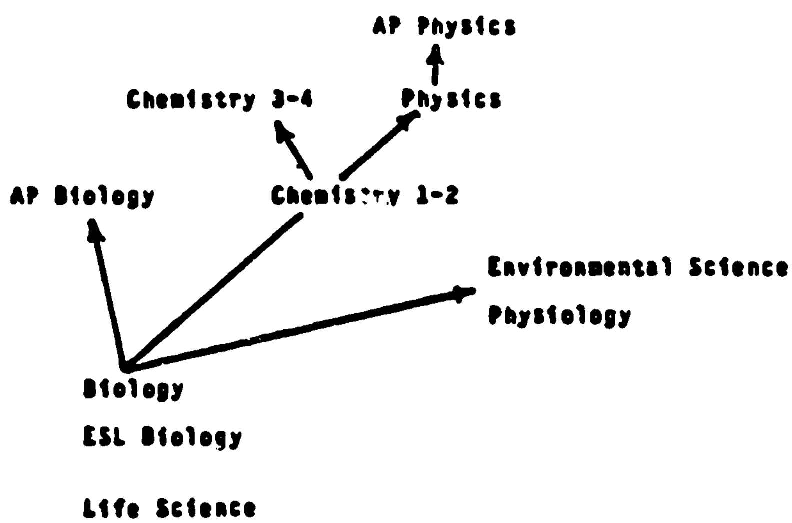


Figure 5

Science Course Chain at South High

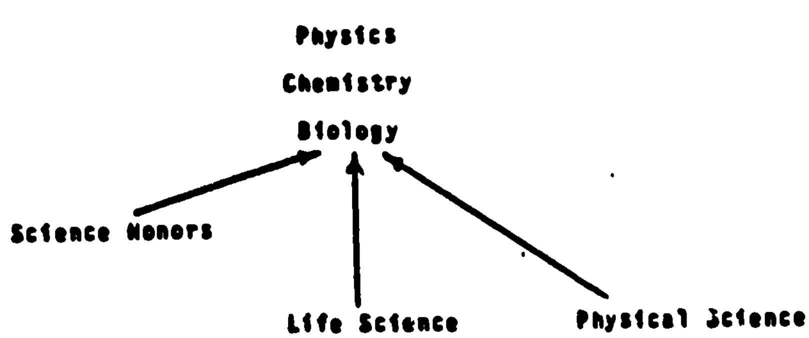


Figure 6

Science Course Chain at Mountain High

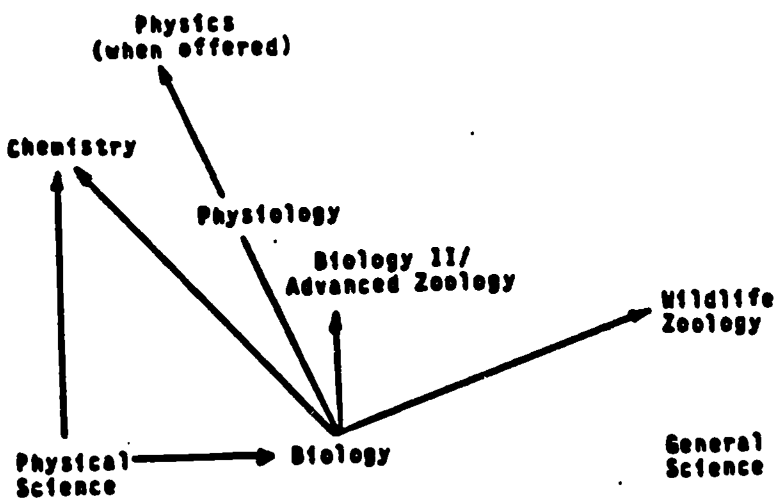
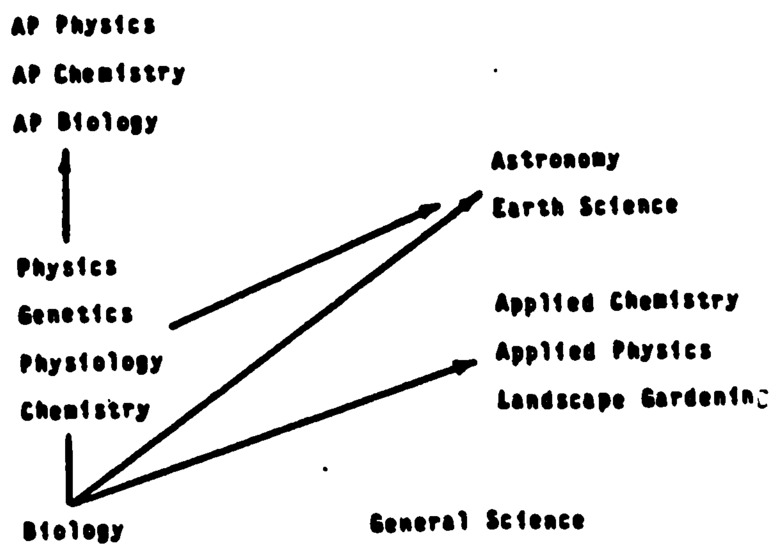


Figure 7

Science Course Chain at Western High



ENTRY OPTIONS

The curriculum path each student follows will to a great extent depend on the options students have at the beginning, their entry options. Factors having to do with entry options, i.e., the grade of entry, course levels available for entry and placement criteria, varied considerably across the schools.

Of the six schools we studied, three enrolled most students in science beginning in grade nine, and three in grade ten. At Vista, delaying science a year was a policy fairly strictly enforced. Less than 10% of the ninth graders were enrolled in science. The department at Kirkland took a different approach and required all ninth graders to enroll in a health/physical science course, in part to allow students four years in which to complete their two year graduation requirement.

One effect of the differences in policy can be seen in the levels of courses students in the grade of entry were taking. The majority of entering students at Kirkland (88%), Vista (70%), Mountain (76%) and Western (81%) began science in a mixed course. At Suburban, about equal numbers went into general (43%) and college-prep (45%) courses, and at South, most entered with a general course (76%). Only Suburban, therefore, had enrolled a large proportion of students in the college-prep path by ninth grade. That school also had a very large proportion of student enrolled in a general course, however.

Given the increase in graduation requirements, the question of grade of entry may be moot. Schools will almost certainly begin students in grade nine to allow them more years to take more science. A two-year graduation requirement at Kirkland, however, increased enrollment in lower-level science courses, but appeared to have little affect on the number ot students taking college-prep courses. As schools revise their science course offerings to accommodate the new requirements, they might do well to consider this example.

EXERCISE OF OPPORTUNITY

Table 1 gives the science enrollment percentages by grade at the study schools. Of the six, Kirkland enrolled the greatest percentage of students (73.3%), presumably because two years of science were required for graduation. The smallest number were enrolled at South (38.4%) and Vista (43.7%). The low figure at South may be explained by the overall low achievement level of the school and the low enrollment in college-prep courses. At Vista, overall science enrollment is affected by the school policy that recommends that students take their initial science course in grade 10, so that less than 10% of the ninth graders are enrolled. At Kirkland, over 97% of ninth grade students are taking science.

Table 1

Percent Science Enrollment by Grade

SCHOOL	GRADE				
	9	10	11	12	Total
Suburban	45.8	69.6	56.2	43.4	54.2
Kirkland[a]	97.3	100.0	49.3	30.6	73.4
Vista	9.7	70.5	63.3	38.3	43.7
South	18.0	58.1	45.3	33.7	38.4
Mountain	63.2	50.8	65.6	43.1	58.1
Western[b]	----	76.8	49.9	47.7	59.4

[a]Science course enrollment figures reflect initial course enrollments; school level enrollment is end-of-semester.
[b]Grades 10-12 only

Table 2 presents the percent of students enrolled at different levels at the six study schools -- remedial, general, mixed, and college-prep. As an additional way of looking at enrollment in science, we have also calculated the percentages of students taking second-year courses as well as those enrolled in advanced college-prep courses, beyond Biology.

Second-year courses included any of those normally taken after the entry level courses. Only South failed to enroll more than 20% of the school population in second-year courses; Mountain, Vista, and Western enrolled around 30% each. These higher enrollments at Mountain may be partially explained by the small enrollment of the school; two sections of a course can account for nearly 15% of the students. At Vista, two factors may be contributing to the higher enrollments. First, students normally do not take science until grade ten, and second, Biology is not acceptable for admission to the University of California. In addition, the large Asian population is heavily represented in the upper level courses. The higher enrollments at Western can be partially attributed to the numbers of students taking the general courses, such as Applied Chemistry, Applied Physics, and Astronomy.

Advanced college-prep courses included in the calculation of percentages were all of those other than Biology, which at Suburban, Kirkland, and South were classified as college-prep. Although Biology may at some schools be the second science course taken, it is always the initial college-prep course.

Suburban, Kirkland, Vista, and Mountain all enroll roughly 20% of the school enrollment in advanced college-prep courses (Table 2). At South and Western, the figure is closer to 10%. Because of the overall student population at South, less participation in college-prep classes is not surprising. Students are largely lower-income Hispanics, and scored near the 30th percentile statewide in reading (Garet & DeLany, 1984). At Western, a different explanation is required. Many students (15.9%) have obviously elected to enroll instead in the array of second-year general courses. The University of Utah accepts any of these courses for admission, and students might also justifiably argue that chances for a good grade with less effort are better in the applied course.

In general, we can see that certain policies regarding the science curriculum structure can affect later enrollment. Offering mixed second-year courses, such as Environmental Science and Physiology at Vista, seems to increase later enrollment without diminishing the number of students enrolling in college-prep courses. A range of general courses offered as alternatives to the college-prep curriculum, however, may have the result of drawing off enrollments from the college-prep courses, as in the case of Western.

Table 2

Percent Science Enrollment by Level

SCHOOL	COURSE LEVEL						
	Percent School Enrollment[a]	Remedial	General	Mixed	College-Prep	Second-year Courses[b]	Advanced College-prep[b]
Suburban	54.2 (1571)	2.8	12.3	----	39.1	20.4	20.4
Kirkland	73.4 (2020)	1.4	14.1	27.3	30.6	20.2	18.4
Vista	43.7 (2703)	4.9[c]	----	24.2	14.6	28.7	21.2
South	38.4 (1148)	---	25.3	----	13.3	9.6	9.6
Mountain	58.1 (465)	5.6	11.2	24.9	16.3	30.6	22.4
Western	59.4 (1972)	3.0	7.3	37.4	11.8	27.7	11.8

chool enrollment in parenthesis
rades 10-12 only
.1% ESL

Increasing course requirements for graduation has become a rallying cry for educational reform. Higher graduation requirements, however, do not significantly affect the enrollment of students in higher-level science courses, at least as far as Kirkland was concerned. The apparent result at that school was instead to raise the enrollments of ninth and tenth grade students in introductory courses (Table 1).

Mobility is limited by the fact that many students take only one year of science. For those students originally enrolled in remedial or general classes, therefore, the question of mobility is irrelevant, since they take no further science. At Kirkland, for example, all ninth graders enroll in the Health/Physical Science sequence and are then placed in either Biology or Life Science. For Life Science students to move into the college-prep path would mean taking a third year of science, and very few elect to do so. A similar situation exists at Vista, Mountain, and Western. There are, in most cases, no rigid restrictions on students enrolling in college-prep science courses, but certain minimal prerequisites do apply.

At Suburban High, ninth graders are enrolled in either a remedial, a general, or a college-prep course. After the first year, therefore, remedial and general students face the opportunity for mobility. School policy states that students wishing to enter Biology must read at the ninth grade level, but how strictly that rule is enforced is unclear. There are indications that quite a few General Science students do move on to Biology. At South High, the majority of students take only Life Science, but, in general, they enjoy considerable freedom of choice, since students are to a great extent responsible for designing their own programs.

Given the number of science courses students actually take and the number required to exercise mobility, the issue becomes less relevant. Once graduation requirements are raised, however, and all students have to take two years of science, the question of mobility may take on additional importance.

SCIENCE EXPERIENCE

While the science curriculum structure controls students' access to science courses, their experience within the course largely determines what they will learn. Consequently, we have included in our conceptualization of opportunity systems an analysis of the students' classroom experience from two perspectives: (1) the emphasis teachers placed upon aspects of scientific literacy, and (2) the nature of instruction students experience.

Teachers' Emphasis on Scientific Literacy. The definition of scientific literacy presented earlier provided a guide for our analysis of classroom instruction. If teachers do not stress scientific literacy, students are not likely to acquire it. We therefore interviewed teachers regarding these points and asked

them to rate on a 5-point scale the emphasis given the elements of scientific literacy. In addition, teachers' attention to scientific literacy in their instruction was noted in classroom observations. They rated the degree of emphasis given various components of scientific literacy in instruction on a 5-point scale; this was collapsed to 3 points prior to analysis because teachers tended not to select on the outer limits. Results are given in Table 3.

Teachers at all levels gave the strongest emphasis to facts/concepts, attitudes, and science methods/process. With the exception of the college-prep teachers, they also emphasized science for personal use to some degree. History of science, science for college, and science, technology, and society (STS) seemed to get the most consistently low ratings.

College-prep and general teachers rated facts highest, with methods and attitudes following. Mixed teachers ranked attitudes and facts highest, but reported emphasizing personal use as well. Remedial teachers placed methods first, followed by personal use and facts; attitudes they rated fourth highest. Taken by level, therefore, there is a trend toward an increasing emphasis on science for personal use as one considers levels from college-prep to remedial on the table.

Teachers at all levels reported giving little emphasis to the history of science, and all but the college-prep teachers also rated science for college low. None of the groups of teachers reported giving STS a strong emphasis in their teaching; the highest rating was from general teachers (2.0). Science for vocation received fairly low ratings from all levels except the general teachers.

These findings suggest that, regardless of the level of a course, teachers tend to emphasize scientific facts/concepts, methods/process, and science attitudes most. Science for personal use seems also to be given some emphasis, depending on the level. Teachers consider the other components of scientific literacy, such as science technology and society, the history of science, and science for vocation to be of less importance to their instructional goals. In a larger sense, these data suggest that the agenda of science educators, as articulated in Project Synthesis (Harms & Yager, 1981), for example, has not made a significant impact on the teachers in these schools. Of the four goal clusters identified by that project (personal needs, societal issues, academic preparation, and career choice), only two are emphasized to a great degree by the teachers in this study.

Nature of instruction. We sought to capture the nature of instruction by observing how much time teachers allocate to a variety of instructional formats, and by rating teachers on the way they organized and carried out instructions.

Table 3

Teachers' Ratings of Science Emphasis by Level

vel	n[a]	Facts/ Con- cepts	History of Science	Science Technol- ogy in Society	Personal Use	College	Vocation	Attitude	Methods/ Process
medial	5	2.40	1.80	1.75	2.60	1.75	1.80	2.50	2.60
xed	20	2.65	1.65	1.95	2.53	1.61	1.74	2.70	2.42
neral	15	2.80	1.93	2.00	2.57	1.60	2.33	2.47	2.53
llege-Prep	20	2.85	1.91	1.88	2.00	2.00	1.94	2.88	2.91
an ting	74	2.75	1.84	1.92	2.29	1.79	1.96	2.73	2.68

= number of teachers

We have depicted the nature of instruction in two ways. First, in observations of selected lessons, we recorded the time spent in various instructional formats: lecture/recitation, seatwork, discussion, demonstrations, laboratory, instruction by a surrogate, and in classroom management. Second, data collectors rated teachers on several factors associated with effective instruction.

Observed time use. A sample of 48 teachers were observed on two occasions each. During each observation, the time spent in a variety of instructional formats was recorded (Table 4).

In the science classes we observed, the greatest amount of time-use was in lecture/recitation and lab activities. For the total group of classes, the most common format was recitation, lab was second, and seatwork was the third. We saw very little use of certain types of activities, such as group discussion, and there were examples of instruction in non-academic areas. Because we wanted to observe teaching rather than materials produced in other contexts, observers avoided days when films were the major activity. Still, surrogate instruction (use of films, videos, or guest lecturers) was observed to a small degree and seemed to depend on individual teachers' styles.

Ratings of teaching behavior. After each observed lesson, data collectors rated teachers on 25 items associated with effective instructional behavior. Ratings on each item were based on a 5-point scale, and we have selected eight for analysis which seemed to form a composite of good teaching. Table 5 lists the Science Class Description items and mean ratings by level across the entire sample of teachers.

Results of the analysis showed that teachers of college-prep courses were rated highest on six of the eight items. Remedial teachers were rated highest for monitoring lab and seatwork (item 24), and there appeared to be no differences in teachers' positive attitude about learning potential (item 28).

Thus, the teachers in the college-prep courses seemed to practice more of those instructional behaviors believed to be associated with effective teaching. They especially seemed better prepared (item 9), more efficient in classroom management (item 22), and used time well, pacing the period (item 29). In addition, they maintained student attention (item 3) to a greater degree than did teachers at other levels, gave clearer directions (item 13), and were rated as more effective overall.

The higher ratings of the college-prep teachers might be partially explained by the make-up of their classes and the subject matter content. More academically-oriented students, for example, might be expected to pay attention more in class and to create an impression of effective classroom management. In addition, it seems that explanations of the more complex concepts covered in advanced college-prep courses might create the appearance that teachers are better prepared. By the same token, however, the

Table 4

Mean Time Use in Science Instruction: Six High Schools[a]

Level	Seat-work	Reci-tation	Discus-sion	Demon-stration	Lab	Surro-gate	Non-Aca-demic	Proce-dures	Transi-tion/Waste	Total
Remedial (n^b=4)	13.4 (23.2)	23.1 (40.0)	---	1.1 (1.9)	11.5 (19.9)	---	.5 (.01)	4.3 (7.3)	3.9 (6.7)	58
Mixed (n=12)	14.3 (27.2)	12.4 (23.6)	---	.13 (.2)	14.9 (28.4)	2.9 (5.6)	.25 (.5)	2.9 (5.5)	4.7 (8.9)	50
General (n=9)	15.1 (22.3)	22.9 (33.8)	1.3 (1.9)	2.7 (3.9)	16.1 (23.7)	1.4 (2.0)	.7 (.97)	1.0 (1.5)	6.7 (9.9)	68
College-Prep (n=23)	8.1 (14.8)	19.9 (36.2)	1.6 (2.9)	1.7 (3.1)	14.7 (26.6)	2.2 (3.9)	.3 (.5)	3.3 (6.0)	3.3 (5.9)	55
Total percent	11.4 (20.1)	18.8 (33.1)	.99 (1.7)	1.4 (2.5)	14.7 (25.8)	2.0 (3.6)	.4 (.6)	2.9 (5.1)	4.3 (7.5)	57

[a]Number in parentheses is percentage
[b]n = number of teachers observed on two occasions

Table 5

Mean Ratings of Instructional Behavior by Course Level:

Six High Schools

Item No.	Item	Remedial (n=4)[a]	Mixed (n=12)	General (n=9)	College-prep (n=23)	Total (n=48)	F
		Course Level					
3	maintains student attention	3.63	3.58	3.44	4.19	3.85	2.29*
8	overall effectiveness of activities	3.13	3.25	3.59	3.94	3.64	2.48*
9	preparation for instruction	3.00	3.04	3.50	3.91	3.54	3.18**
13	clarity of teacher's directions	3.25	3.54	3.76	4.07	3.81	2.28*
22	efficiency of classroom management	3.25	3.21	3.19	4.06	3.61	3.08**
24	monitors lab and seatwork	4.25	3.17	2.50	3.10	3.10	2.59*
28	positive attitude about learning potential	3.25	3.46	3.33	3.86	3.61	0.924
29	paces period	3.38	3.08	2.30	3.61	3.21	3.209**

[a]n = number of teachers
*p = <.1
**p = <.05

lower rating college-prep teachers received for monitoring lab and seatwork might be attributed to their perception that college-prep students can work independently. Teachers in remedial classes had to provide more guidance and supervision than did their college-prep counterparts.

Ratings on all items were relatively high. Only on two items was the mean rating less than three on a 5-point scale. College-prep teachers, however received consistently higher ratings on most of the instructional behaviors associated with effective teaching. Students in college-prep courses may be receiving better instruction, and opportunities for science literacy are increased if one can gain access to those courses.

CONCLUSION

Our research shows that high school science teachers give priority to facts, methods, and attitudes. Science for personal use is emphasized somewhat by teachers at all levels, but mostly teachers of remedial and mixed courses. The other components of scientific literacy (science, technology and society, history of science, and science for vocation) are more peripheral concerns. These findings suggest that the priorities of national leaders in science education have influenced classroom teachers very little, if at all. Pressures to "cover the curriculum" and emphasize "the basics" have meant science applications take a back seat in their instruction. When interviewed, many teachers seemed to have well-articulated notions of scientific literacy issues, and several reported devoting class time to the different components. Our observations showed that while science literacy components were occasionally introduced into instruction, for the most part they did not form an integral part of the curriculum.

Students in college-prep courses may, thus, have increased opportunities for scientific literacy because of the instruction they receive. This suggests that if opportunities for all students are to be increased, then teaching at the remedial and other levels must be improved. Teachers normally assigned college-prep classes might also be required to teach more of the introductory and remedial classes.

Local context factors such as the size and make-up of the school population no doubt influence policy decisions at the school regarding course offerings, teaching load, and requirements. It also appears, however, that these choices reflect more basic educational goals. The stream-lined science curriculum at Suburban and the eclectic offerings at Western provide contrasting examples. These choices affect the workload of teachers, organization of the school day, and graduation requirements.

Opportunity seems to be increased when these factors are balanced against each other in ways that students of varying

interests and abilities are provided options. Teaching responsibilities should be kept at manageable levels. Longer class periods are an attractive alternative, and ways of acommodating them deserve exploration. The controversy which may arise from such policy changes, however, was described in the study of Mountain High.

The findings of the study have implications for both teacher training and inservice and for the design and implementation of science programs. For teacher training, attention should be given to raising:

- teachers' awareness about the importance of scientific literacy, and
- the quality of teaching across courses at different levels.

In the design and implementation of programs, consideration should be given to:

- ways in which aspects of the science curriculum structure can be manipulated to increase the range of students' choices and the quality of their science experience,
- the offerings for students of different interests,
- the entry options available to students,
- the degree to which students take higher levels of science, and
- implementation of policies (e.g., graduation requirements) at the school level.

Action in these areas will help to equalize the opportunities of all students, regardless of interests or abilities, to develop literacy in science.

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